CLAIMS

1. A process for cleaning a substance comprising a dielectric constant greater than the dielectric constant of silicon dioxide from at least a portion of a surface of a reactor, the process comprising:

introducing a first gas mixture comprising a boron-containing reactive agent into the reactor wherein the first gas mixture reacts with the substance contained therein to provide a volatile product and a boron-containing by-product;

introducing a second gas mixture comprising a fluorine-containing reactive agent into the reactor wherein the second gas mixture reacts with the boron-containing by-product contained therein to form the volatile product; and

removing the volatile product from the reactor.

2. The process of claim 1, wherein the reactor is an atomic layer deposition reactor.

3. The process of claim 1, wherein the second introducing step is conducted during at least a portion of the first introducing step.

4. The process of claim 1 wherein the second introducing step is conducted upon the completion of the first introducing step.

5. The process of claim 1 wherein the removing step is conducted during at least a portion of the first and/or the second introducing steps.

6. The process of claim 1 wherein the first and the second introducing steps are alternated a plurality of times.

7. The process of claim 1, wherein the substance is at least one member selected from a transition metal oxide, a transition metal silicate, a Group 13 metal oxide, a Group 13 metal silicate, a nitrogen-containing Group 13 metal oxide, a nitrogen-containing Group 13 metal silicate, a nitrogen-containing transition metal oxide, a nitrogen-containing transition metal silicate, or a laminate comprising at least one layer of the group consisting of a transition metal oxide, a transition metal silicate, a Group 13 metal oxide, a Group 13 metal silicate, a nitrogen-containing Group 13 metal

oxide, a nitrogen-containing Group 13 metal silicate, a nitrogen-containing transition metal oxide, a nitrogen-containing transition metal silicate, and mixtures thereof.

8. The process of claim 1, wherein the substance is at least one selected from Al_2O_3, HfO_2, ZrO_2, $HfSi_xO_y$, $ZrSi_xO_y$ and mixtures thereof, wherein x is a number greater than 0 and y is 2x + 2, and any of the aforementioned compounds containing nitrogen.

9. The process of claim 1 wherein the boron-containing reactive agent is at least one selected from BCl_3, BBr_3, BI_3, BF_3, and mixtures thereof.

10. The process of claim 9, wherein the boron-containing reactive agent is BCl_3.

11. The process of claim 1, wherein the fluorine-containing reactive agent is at least one selected from NF_3, ClF_3 , ClF, SF_6, a perfluorocarbon, a hydrofluorocarbon, an oxyfluorocarbon, a hypofluorite , a fluoroperoxide, a fluorotrioxide, COF_2, NOF, F_2, NF_xCl_{3-x} wherein x is a number ranging from 1 to 2, and mixtures thereof.

12. The process of claim 11, wherein the fluorine-containing reactive agent is NF_3.

13. The process of claim 11, wherein the fluorine-containing reactive agent is F_2.

14. The process of claim 1, wherein the first gas mixture and/or the second gas mixture is conveyed to the reactor from at least one gas cylinder, a safe delivery system, or a vacuum delivery system.

15. The process of claim 1, wherein the first gas mixture and/or the second gas mixture is formed in situ by a point-of-use generator.

16. The process of claim 1, wherein the first gas mixture and/or the second gas mixture further comprises an inert gas diluent.

17. The process of claim 16, wherein the inert gas diluent is selected from nitrogen, CO, helium, neon, argon, krypton, xenon, and mixtures thereof.

18. A process for removing a substance from at least a portion of the surface of a reactor, the process comprising:

providing the reactor wherein at least a portion of the surface is at least partially coated with the substance and wherein the substance has a dielectric constant of 4.1 or greater and is at least one member of the group consisting of a transition metal oxide, a transition metal silicate, a Group 13 metal oxide, a Group 13 metal silicate, a nitrogen containing Group 13 metal oxide, a nitrogen containing Group 13 metal silicate, a nitrogen containing transition metal oxide, a nitrogen containing transition metal silicate, or a laminate comprising at least one layer of the group consisting of a transition metal oxide, a transition metal silicate, a Group 13 metal oxide, a Group 13 metal silicate, a nitrogen containing Group 13 metal oxide, a nitrogen containing Group 13 metal silicate, a nitrogen containing transition metal oxide, a nitrogen containing transition metal silicate;

introducing a first gas mixture comprising a boron-containing reactive agent into the reactor;

exposing the first gas mixture to one or more energy sources sufficient to generate active species that react with the substance and form a volatile product and a boron-containing byproduct; and

introducing a second gas mixture comprising a fluorine-containing reactive agent into the reaction reactor;

exposing the second gas mixture to one or more energy sources sufficient to generate active species that react with the boron-containing byproduct and form the volatile product; and

removing the volatile product from the reactor.

19. The process of claim 18 wherein the first gas mixture is exposed to one or more energy sources and the first exposing step is conducted prior to the second introducing step.

20. The process of claim 18 wherein the first gas mixture is exposed to one or more energy sources and the first exposing step is conducted during at least a portion of the first introducing step.

21. The process of claim 18 wherein the second gas mixture is exposed to one or more energy sources and the second exposing step is conducted during at least a portion of the second introducing step.

22. The process of claim 18 wherein a temperature of the first and/or second exposing step is at least 150°C.

23. The process of claim 18 wherein a pressure of the first and/or second exposing step is at least 10 mTorr.

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